

May 25, 2006

EA-06-081

Mr. Christopher M. Crane  
President and Chief Nuclear Officer  
Exelon Nuclear  
Exelon Generation Company, LLC  
4300 Winfield Road  
Warrenville, IL 60555

SUBJECT: BRAIDWOOD NUCLEAR POWER PLANT, UNITS 1 AND 2, BASELINE  
INSPECTION REPORT 05000456/2006008(DRS); 05000457/2006008(DRS);  
PRELIMINARY WHITE FINDING

Dear Mr. Crane:

On May 25, 2006, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at your Braidwood Nuclear Station Units 1 and 2. The preliminary results of this inspection were discussed on May 25, 2006, with Mr. K. Polson and other members of your staff.

The inspection examined activities conducted under your licenses as they relate to safety and to compliance with the Commission's rules and regulations and with the conditions of your licenses. Specifically, the inspection focused on the characterization and evaluation of onsite and offsite tritium contamination that was reported to the NRC Region III staff on November 30, 2005. The inspectors reviewed selected procedures and records, observed activities, collected independent and confirmatory samples for analysis by NRC's contract laboratory, and interviewed station personnel.

We recognize the extensive, recent monitoring performed by your staff to identify the extent of the contamination from historical leaks from the circulating water blowdown line vacuum breakers. The NRC has also performed confirmatory measurements to provide an independent verification of your results. In this case, the contamination is limited to the radionuclide tritium. Tritium is a low energy beta emitter which represents a very low radiological risk as compared to other radionuclides. Based upon the current radiological conditions and the concentrations of tritium identified at the Braidwood site, the NRC estimated that the doses from the contamination to be a very small fraction of the NRC's limit for doses to members of the public and insignificant relative to normal background radiation dose. We have also received a more comprehensive assessment from your staff that calculated bounding doses for the historical, unplanned radioactive releases. This assessment is more fully described in Section 2PS1.3 of the enclosed report. Although the details of your assessment remain under review by the NRC staff, our inspection determined that public health and safety has not been, nor is likely to be, adversely affected by the historical circulating water blowdown line vacuum breaker leaks. Additional information relative to tritium, its properties, and its radiological characteristics may be found at <http://www.nrc.gov/reactors/operating/ops-experience/grndwtr-contam-tritium.html>.

Despite your recent monitoring activities to address the groundwater issue, we concluded that your staff did not perform adequate, timely radiological evaluations following the historical leaks, which impacted your ability to assess the environmental impact from the releases and to mitigate the releases; did not account for the potential public impact; and did not adequately control licensed material. The multiple failures of your staff to adequately evaluate the radiological hazards associated with the leaks from the circulating water blowdown line vacuum breakers and to assess the resultant environmental impact were determined to be a finding, which was assessed applying the public radiation safety significance determination process (NRC Manual Chapter 0609, Appendix D).

The NRC's public radiation safety significance determination process was developed to assess the risk of licensee non-compliance with regulatory requirements and licensee programs and procedures. The preliminary significance of the NRC's finding was not based on the risk from offsite dose. The public radiation safety significance determination process also considers the potential impact of program breakdowns. In developing the reactor oversight program, the NRC recognized that a licensee's control of radioactive material is of interest to members of the public, even when, as in this case, very low levels of radioactive materials are involved. Consequently, the NRC integrated a deterministic factor into the public radiation safety significance determination process, which provides for a higher level of significance than would be warranted based solely on the risk from exposure to the radioactive material. In this case, the preliminary significance of the NRC's finding is based on the adequacy of the licensee's controls and assessments of environmental impact.

In our preliminary determination, we assessed the finding utilizing the environmental monitoring program pathway within the significance determination process, as described in Section 2PS1 of this report. We determined that your long-term lack of timely radiological monitoring and assessments following the leaks from the circulating water blowdown line vacuum breakers and failure to revise your environmental monitoring program concurrently to evaluate the impacts to the groundwater pathway resulted in an impaired ability to assess the environmental impact. Furthermore, we concluded that the absence of any environmental monitoring data prior to 2005 for that leakage pathway and the impact from the leaks also resulted in no assessment of the environmental impact between 1996 and 2005. Although your staff was knowledgeable of these leaks when they occurred, they did not fully recognize the potential radioactive component of the leaks and did not respond properly. Based on this assessment, we have preliminarily determined that the finding is White. This finding applies to both units.

The finding also involved five apparent violations of NRC requirements (effective at the time of the leaks): (1) the failure to perform adequate radiological surveys, as required by 10 CFR 20.1501; (2) the failure to adequately implement a program to assess the cumulative dose contributions, as required by Technical Specification 6.8.4.e.5; (3) the failure to conduct an adequate environmental monitoring program to provide data on measurable levels of radiation and radioactivity in the environment resulting from the releases, as required by Technical Specification 6.9.1.6; (4) the failure to report the unplanned releases in annual reports, as required by Technical Specification 6.9.1.7; and (5) the failure to maintain records of

the spills that resulted in the spread of contamination in and around the facility, as required by 10 CFR 50.75(g) and which are being considered for enforcement action in accordance with the NRC's Enforcement Policy. The current Enforcement Policy is included on the NRC's Web site at <http://www.nrc.gov/reading-rm/adams.html>.

The significance determination process encourages an open dialogue between the staff and the licensee; however, the dialogue should not impact the timeliness of the staff's final determination. Before we make a final decision on this matter, we are providing you an opportunity: (1) to present to the NRC your perspectives on the facts and assumptions, used by the NRC to arrive at the finding, at a Regulatory Conference; or (2) submit your position on the finding to the NRC in writing. If you request a Regulatory Conference, it should be held within 30 days of the receipt of this letter and we encourage you to submit supporting documentation on the docket at least 1 week prior to the conference in an effort to make the conference more efficient and effective. If a Regulatory Conference is held, it will be open for public observation. If you decide to submit only a written response, such submittal should be sent to the NRC within 30 days of the receipt of this letter.

Please contact Steven Orth at (630) 829-9827 within 10 business days of the date of receipt of this letter to notify the NRC of your intentions. If we have not heard from you within 10 days, we will continue with our determination and enforcement decision and you will be advised via separate correspondence of the results of our deliberations on this matter.

Since the NRC has not made a final determination in this matter, no Notice of Violation is being issued for the inspection finding at this time. In addition, please be advised that the characterization of the apparent violations described in this letter may change as a result of further NRC review.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS), accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Sincerely,

**/RA by A. Boland acting for/**

Cynthia D. Pederson, Director  
Division of Reactor Safety

Docket Nos. 50-456; 50-457  
License Nos. NPF-72; NPF-77

Enclosure: Inspection Report 05000456/2006008; 05000457/2006008  
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the spills that resulted in the spread of contamination in and around the facility, as required by 10 CFR 50.75(g) and which are being considered for enforcement action in accordance with the NRC's Enforcement Policy. The current Enforcement Policy is included on the NRC's Web site at <http://www.nrc.gov/reading-rm/adams.html>.

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License Nos. NPF-72; NPF-77

Enclosure: Inspection Report 05000456/2006008; 05000457/2006008  
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U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos: 50-456, 50-457  
License Nos: NPF-72, NPF-77

Report No: 05000456/2006008; 05000457/2006008(DRS)

Licensee: Exelon Generation Company

Facility: Braidwood Nuclear Power Station, Units 1 and 2

Location: Braceville, IL

Dates: February 13, 2006 through May 25, 2006

Inspectors: S. Orth, Plant Support Team Leader  
J. Cassidy, Radiation Specialist

NRC Sampling and  
Analysis: W. Snell, Senior Health Physicist  
E. Bonano, Health Physicist

Approved by: C. Pederson, Director  
Division of Reactor Safety

Enclosure

## SUMMARY OF FINDINGS

IR 05000456/2006008; IR 05000457/2006008(DRS); 02/13/06 - 05/25/2006; Exelon Generation Company, Braidwood Nuclear Power Station, Units 1 and 2; Event Follow-up and Public Radiation Safety.

The report covered the inspection activities for an unresolved item regarding the migration of tritium to the unrestricted areas and to the environment. The inspection was conducted by two regional inspectors with resident inspector support. The inspection identified one preliminary White finding and five associated apparent violations (AVs). The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

### A. Inspector-Identified and Self-Revealed Findings

#### **Cornerstone: Public Radiation Safety**

Preliminary White. A finding and five AVs of NRC requirements were identified associated with unplanned radioactive leaks from vacuum breakers along the circulating water blowdown line that occurred in 1996 through 2005 and that resulted in the spread of radioactive contamination in groundwater beyond the site boundary. Based on these events, apparent violations of 10 CFR 20.1501; Technical Specifications 6.8.4.e.5, 6.9.1.6, and 6.9.1.7; and 10 CFR 50.75(g) were identified. Following each leak, the licensee failed to perform adequate radiological surveys to characterize the hazard and to assess the dose to the public and, for certain releases, to report the unplanned occurrences in required annual reports and to maintain records of the contamination for decommissioning purposes. In addition, the licensee failed to revise its radiological environmental monitoring program in a timely manner to ensure that the impact to the groundwater effluent pathway resulting from the unplanned radioactive releases was adequately monitored.

The finding was determined to be more than minor because the finding was associated with the Program & Process attribute of the Public Radiation Safety Cornerstone and potentially affected the cornerstone objective to ensure adequate protection of the public from exposure to radioactive materials from the release of liquid effluents. Although the finding has been determined to not result in any public health risk, the finding was preliminarily determined to be a White finding following the significance determination process (SDP) evaluation because of the licensee's failure to assess the impact on the environment from the leakage pathway. Corrective actions taken by the licensee included the cessation of all liquid radioactive releases through the circulating water blowdown line, performing a plume characterization study, and performing a bounding dose analysis.



Based on current environmental measurements, the calculated doses to members of the public from the contamination represent a very small fraction of the NRC's limit for doses to members of the public and insignificant relative to normal background radiation dose. Our inspection determined that public health and safety has not been, nor is likely to be adversely affected by the historical circulating water blowdown vacuum breaker leaks. (Sections 2PS1)

**B. Licensee-Identified Violations**

No violations of significance were identified.

## REPORT DETAILS

### 2. RADIATION SAFETY

#### **Cornerstone: Public Radiation Safety**

2PS1 Radioactive Gaseous and Liquid Effluent Treatment and Monitoring Systems (71122.01)

.1 Radiological assessment of unplanned radioactive releases from the circulating water blowdown line

a. Inspection Scope

The inspectors reviewed the licensee's radiological assessment of leaks from the circulating water (CW) blowdown line that occurred from November 1996 through November 2005, which resulted in the spread of contamination (tritium) in the groundwater both onsite and beyond the site boundary. The inspectors reviewed historical records to evaluate the licensee's response to the leaks, including radiological surveys, dose assessments, and mitigative actions. The inspectors' evaluation was performed to determine if the licensee adequately implemented the requirements contained in 10 CFR Part 20 and the licensee's Technical Specifications. Specifically, the inspectors discussed aspects of the 1996, 1998, and 2000 leaks from Vacuum Breakers No. 1, No. 3, and No. 2, respectively, as well as other leaks from the vacuum breakers with licensee staff. The inspectors also reviewed:

- radiation protection surveys for affected areas;
- maintenance work orders for selected vacuum breakers associated with the releases;
- identification of potential pathways based upon release location;
- reports contained in the licensee's corrective action program for these events;
- parameters and results of licensee's groundwater characterization study;
- files that contain environmental contamination events;
- select annual effluent release reports; and
- select liquid effluent release permits.

b. Findings

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Introduction: A self-revealed preliminary White finding and five apparent violations (AVs) were identified following the review of the events that resulted in the identification of tritium in onsite and offsite groundwater monitoring wells. The inspectors identified a failure to perform adequate radiological evaluations of the leaks that occurred on the blowdown line necessary to properly quantify and assess the radiological impact of the leaks and to report and document the associated releases.

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Description: On November 30, 2005, the NRC Region III office was notified that the licensee had measured tritium levels as high as 58,000 picocuries per liter (pCi/L) in shallow, groundwater monitoring wells located at the northern edge of the owner controlled area. The licensee attributed the contamination to historical leakage of vacuum breakers along the circulating water blowdown line that is routinely used for

radioactive liquid releases to the Kankakee River. As an immediate corrective action, the licensee suspended all further releases of liquid radioactive material, while the licensee performed a more comprehensive evaluation of the incidents.

During March 2005, the licensee was notified by the Illinois Environmental Protection Agency of reports of tritium in wells in a nearby community. Following that notification, the licensee began monitoring groundwater between the community and the Braidwood station and obtained samples from a drainage ditch that was near the community. While no contaminated groundwater was identified, the licensee did measure levels of tritium in the drainage ditch near the Braidwood access road. The licensee performed additional monitoring to identify the source of that tritium contamination.

Between March 2005 and March 2006, the licensee sampled the wells of several homeowners with drinking water wells and installed groundwater monitoring wells to determine the extent of the tritium contamination. Beginning in December 2005, the NRC performed an independent analysis of split samples taken from some of the licensee's monitoring wells and collected independent samples from some residents nearest to the site boundary. The NRC sample results were consistent with the licensee's results.

The licensee identified tritium levels between 1400 and 1600 pCi/L in one residential drinking water well. The tritium levels detected in that well were below the Environmental Protection Agency (EPA) drinking water standard of 20,000 pCi/L. The tritium levels also corresponded to calculated doses which are well below the corresponding NRC dose limits. The remaining residential well samples had no measurable tritium above normal background levels. However, the licensee's monitoring identified an area of contaminated groundwater that extended about 2000 to 2500 feet north of the site boundary. Initial measurements by the licensee and independent measurements by the NRC confirmed that gamma emitting radionuclides and strontium-90 were not detected in the contaminated groundwater.

The inspectors reviewed the origin of the tritium contamination with the licensee's staff. Based on the information presented and the licensee's measurements, the inspectors confirmed that the measured levels of tritium in the environment were consistent with past leakage of the vacuum breakers on the circulating water blowdown line. That line normally carried non-radioactive CW discharge back to the Kankakee River but also served as a dilution pathway for planned liquid radioactive releases. The line was about 5 miles long and contained 11 vacuum breakers that compensated for pressure transients within the line from liquid surges. The licensee's recent investigation identified that significant unplanned radioactive releases from three of these vacuum breakers during 1996, 1998, and 2000 and other minor releases between 1996 and 2005 entered the groundwater system. The 1996 event resulted in the leakage of an estimated 250,000 gallons of water. The 1998 and 2000 events each resulted in a leakage of an estimated 3,000,000 gallons of water. Each leak from a vacuum breaker occurred over a period coincident with ongoing, liquid radioactive releases through the blowdown line. The inspectors reviewed the licensee's effluent release documents for the time periods described above and confirmed that intended releases would have met NRC requirements if the releases had been made to the Kankakee River.

Following the 1996 and 1998 vacuum breaker leaks, the licensee failed to recognize the potential radiological component of the leaks and, consequently, failed to perform any radiological measurements to evaluate the quantity of radioactive material that was released from the line through the vacuum breakers and to evaluate its impact to the public and the environment. Following the 2000 vacuum breaker leakage incident, the licensee sampled, collected, and returned the available surface water to the blowdown line. Although the licensee's corporate staff developed a plan to evaluate the potential for groundwater contamination, the plan was not implemented due to a lack of continuity during personnel changes. Consequently, the licensee failed to account for and to evaluate the potential impact to the groundwater pathway. The licensee also identified several (approximately 14) smaller leaks from other vacuum breakers leaks during its root cause evaluation, which also were not adequately evaluated. Based on a review of licensee records and discussion with licensee staff, the inspectors concluded that the licensee failed to perform adequate radiological evaluations following each of the leaks from the blowdown line vacuum breakers. Although the licensee had recognized each leak and appeared to correct the applicable mechanical issues related to individual vacuum breakers, the licensee failed to adequately evaluate the radiological hazards associated with the leakage, to calculate a dose to a member of the public, to revise its environmental monitoring program to adequately measure the impact to the environment, to report aspects of the leakage in its annual report, and to record the residual contamination in files for decommissioning purposes.

Analysis: The inspectors identified a performance deficiency in that the licensee failed to perform adequate radiological evaluations of the leaks from the blowdown line vacuum breakers necessary to properly quantify, assess, and report the radiological impact of these associated releases. In accordance with Inspection Manual Chapter (IMC) 0612, "Power Reactor Inspection Reports," Appendix B, "Issue Screening," issued on May 19, 2005, the inspectors determined that the issue was associated with the Program & Process attribute of the Public Radiation Safety Cornerstone and potentially affected the cornerstone objective to ensure adequate protection of the public from exposure to radioactive materials from the release of liquid effluents. Therefore, the issue was more than minor and represented a finding which was evaluated using the Significance Determination Process (SDP).

Since the finding involved a problem with the licensee's radiological effluent and environmental assessment program, the inspectors utilized IMC 0609, Appendix D, "Public Radiation Safety SDP," to assess its significance. This failure was evaluated with the Environmental Monitoring Program branch of the SDP:

Impaired Ability to Assess Environmental Impact: The failure to perform timely radiological assessments and monitoring following the leaks and to revise its environmental monitoring program concurrently to provide data on measurable levels of radioactivity in the environment to evaluate the impacts to the groundwater pathway impaired the licensee's ability to assess the environmental impact of the releases. At the time of the releases, the licensee's groundwater sampling was performed near the Kankakee River and at the Braidwood City Well (deep well), which would not have been affected by the leaks from the vacuum breakers.

Failed to Assess Environmental Impact: Although the licensee had undertaken recent, significant efforts to monitor the current environmental impact, the licensee did not monitor the groundwater pathway near the site at the time of the releases nor in the short term afterwards. As such, the licensee did not have any environmental monitoring data prior to 2005 for that pathway and the impact of the vacuum breaker leaks. Consequently, the licensee failed to assess the environmental impact of these leaks between 1996 and 2005 in a timely manner, which could have afforded the opportunity for earlier mitigative measures.

Based on the Public Radiation Safety SDP, the inspectors preliminarily determined that the finding is White.

Enforcement: The licensee's actions following the leaks from the circulating water line represent multiple examples of five apparent violations.

1. 10 CFR 20.1501 requires that each licensee make or cause to be made surveys that may be necessary for the licensee to comply with the regulations in Part 20 and that are reasonable under the circumstances to evaluate the extent of radiation levels, concentrations or quantities of radioactive materials, and the potential radiological hazards that could be present. Pursuant to 10 CFR 20.1003, *survey* means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

10 CFR 20.1301 requires the licensee to conduct operations so that the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year.

Between November 1996 and March 2005, the licensee did not make surveys to evaluate the potential hazards and to assure compliance with 10 CFR 20.1301, which limits radiation exposure to members of the public from licensed operations to 0.1 rem. Specifically, in November 1996, December 1998, and November 2000, failed vacuum breakers in the licensee's radioactive waste blowdown line resulted in large volumes of liquid contaminated with licensed material to leak in an uncontrolled manner to the unrestricted areas. Following the identified releases of radioactive material, the licensee failed to perform an adequate radiological survey to identify the extent of radiation levels, to evaluate the potential hazards associated with the radioactive material, and to ensure that the dose to the public did not exceed the levels specified in 10 CFR 20.1301. (AV 05000456, 457/2006008-01)

2. Technical Specification 6.8.4.e.5 requires that the licensee maintain and implement a program to determine the cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year in accordance with the methodology and parameters in the Offsite Dose Calculation Manual (ODCM) at least once per 31 days.

Between November 1996 and March 2006, the licensee failed to determine the cumulative dose contributions from liquid effluents that inadvertently leaked into onsite and offsite groundwater (resulting from failed vacuum breakers along the circulating water blowdown line in 1996, 1998, and 2000) in accordance with the methodology and parameters in the ODCM within 31 days. Specifically, an estimated 250,000 gallon leak from Vacuum Breaker No.1 in November 1996 released water with radioactive material to the groundwater pathway; however, the licensee did not determine the dose from the release. In December 1998, an estimated 3 million gallon leak from Vacuum Breaker No. 3 released water with radioactive material to the groundwater pathway; however, the licensee did not determine the dose from the release. In November 2000, an estimated 3 million gallon leak from Vacuum Breaker No. 2 released water with radioactive material to the groundwater pathway; however, the licensee did not determine the dose from the release. (AV 05000456, 457/2006008-02)

3. Technical Specification 6.9.1.6 requires that the Annual Radiological Environmental Operating Report include summaries, interpretations, and analyses of trends of the results of the radiological environmental monitoring program for the reporting period and that the material shall be consistent with the objectives outlined in the Offsite Dose Calculation Manual (ODCM) and in 10 CFR Part 50, Appendix I, Sections IV.B.2, IV.B.3, and IV.C.

10 CFR Part 50, Appendix I, Section IV.B.2 states the licensee shall establish an appropriate surveillance and monitoring program to provide data on measurable levels of radiation and radioactive materials in the environment to evaluate the relationship between quantities of radioactive material released in effluents and resultant doses to individuals from principal pathways of exposure.

Between November 1996 and March 2006, the licensee did not establish an appropriate surveillance and monitoring program to evaluate the relationship between quantities of radioactive material released in effluents and resultant doses to individuals from principal pathways of exposure. Specifically, the unplanned radioactive material released in 1996, 1998, and 2000 from the circulating water blowdown line vacuum breakers constituted new principal pathways of exposure (i.e., the groundwater pathway) which the licensee had not adequately evaluated with the existing Radiological Effluent Monitoring Program (REMP). (AV 05000456, 457/2006008-03)

4. 10 CFR 50.75(g) requires each licensee to keep records of information important to the safe and effective decommissioning of the facility in an identified location until the license is terminated by the Commission. The Commission considers information important to the decommissioning to include records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site. These records may be limited to instances when significant contamination remains after any cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas as in the case of possible seepage into porous materials such as concrete. These records must include any known information on identification of involved nuclides, quantities, forms, and concentrations.

As of March 6, 2006, the licensee did not keep records of spills or other unusual occurrences involving the spread of contamination in and around the facility for the 1996 or 1998 unplanned radioactive releases from the circulating water blowdown line vacuum breakers. Specifically, in November 1996, an estimated 250,000 gallon leak from Vacuum Breaker No. 1 released water with unknown quantities of radioactive material to the groundwater pathway that was not recorded. In December 1998, an estimated 3 million gallon leak from Vacuum Breaker No. 3 released water with unknown quantities of radioactive material to the groundwater pathway that was not recorded.  
(AV 05000456, 457/2006008-04)

5. Technical Specification 6.9.1.7 requires that the Radioactive Effluent Release Report include a summary of the quantities of radioactive liquid and gaseous effluent and solid waste released from the facility during the prior year and that the material shall be consistent with the objectives outlined in the ODCM and in 10 CFR Part 50, Appendix I, Section IV.B.1.

The ODCM Section 12.6.2 requires, in part, that the Annual Radioactive Effluent Release Report include a list and description of unplanned releases from the site to areas beyond the site boundary of radioactive materials in gaseous and liquid effluents made during the reporting period.

As of March 6, 2006, the licensee failed to identify the occurrence of unplanned releases of radioactive liquid effluent that correspond to the vacuum breaker leaks to areas beyond the site boundary in the 1996 and 1998 Annual Radiological Environmental Operating Reports. Specifically, in November 1996, an estimated 250,000 gallon leak from Vacuum Breaker No. 1 released water with unknown quantities of radioactive material to the groundwater pathway that was not reported in the 1996 annual report. In December 1998, an estimated 3 million gallon leak from Vacuum Breaker No. 3 released water with unknown quantities of radioactive material to the groundwater pathway that was not reported in the 1998 annual report. (AV 05000456, 457/2006008-05)

.2 Characterization of the extent of tritium groundwater contamination from the unplanned radioactive releases from the circulating water blowdown line vacuum breakers

a. Inspection Scope

\_\_\_\_\_ The inspectors reviewed the licensee's radiological monitoring and assessments performed during March 2005 through March 2006, to characterize the extent of groundwater contamination from blowdown line vacuum breaker leakage. Specifically, the inspectors reviewed:

- the licensee's characterization report, which documented the local hydrogeology around the facility through the installation of groundwater monitoring wells on licensee owned property around the blowdown line;
- the licensee's sampling and analysis program, which included groundwater and drinking water samples from private wells near the blowdown line; and

- the licensee's evaluation of blowdown line integrity, which included acoustical monitoring of the line.

The inspectors compared the licensee's results to the independent analysis performed by the NRC's contract laboratory to evaluate the accuracy of the licensee's measurements. The tritium results from the NRC's independent analysis of split sample and samples that were independently obtained by the NRC are included in Appendix A to this report.

b. Findings

No findings of significance were identified.

The inspectors independently estimated the extent and magnitude of the groundwater tritium contamination through NRC's contract analysis of water samples collected from residential drinking wells near the facility and from shallow monitoring wells installed by the licensee. The NRC's contract laboratory analyzed the samples for tritium contamination. In addition, the NRC's contract laboratory analyzed selected samples for other radionuclides using gamma spectroscopy, and analyses have also been performed for Strontium-90 (Sr-90) and Technetium-99 (Tc-99). The contract laboratory also utilized special techniques to identify "difficult to detect" radionuclides, such as Iron-55 (Fe-55), Nickel-63 (Ni-63), and transuranic elements.

The NRC's results confirmed that tritium was present in one offsite residential well at levels of about 1300 to 1500 picocuries per liter, which is a small fraction of the EPA drinking water standard of 20,000 picocuries per liter. In all other residential wells, no measurable levels of tritium or other licensed radioactive material above normal background have been detected. In a deeper onsite groundwater well, the NRC measured tritium as high as 282,000 picocuries per liter. Measurable levels of tritium have been found offsite in shallow monitoring wells and in a pond located near plant boundary. Appendix B contains a map of the area near the plant and the corresponding tritium results from various locations. The colored dose gradients represent licensee monitoring results while the specific values annotated indicate selected NRC monitoring results

.3 Assessment of offsite doses from the leaks releases from the circulating water blowdown line

a. Inspection Scope

The inspectors reviewed the licensee's assessment of the bounding dose from historical releases from the circulating water blowdown line vacuum breakers, which was completed by the licensee near the end of the NRC's inspection. The inspectors reviewed the assessment to ensure that the licensee provided a technically sound basis for its underlying assumptions (historical, current, and projected radiological source terms), included the most probable exposure pathways, and calculated the doses using technically sound health physics principles. The inspectors also compared the licensee's dose estimates to the NRC dose limits contained in 10 CFR 20 and the licensee's Technical Specifications.



b. Findings

The licensee calculated an estimated bounding dose of about 0.16 millirem per year from the ingestion of drinking water from the contaminated residential drinking water well that contained about 1500 pCi/l of tritium from the vacuum breaker releases. That calculation was based on a hypothetical child consuming the tritiated water and was performed using the methods of Regulatory Guide 1.109, "Calculation of Annual Dose to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I." The licensee also performed an additional calculation that considered the actual residents. Based on that most reasonable scenario defined by the licensee, the licensee calculated a maximum dose of about 0.072 millirem per year to a member of the public. That scenario was based on adults consuming the tritiated water and used the updated NRC guidance contained in NUREG/CR 4013, "LADTAP II – Technical Reference and User Guide." The NRC inspectors also calculated a dose of about 0.07 millirem to an adult using applicable NRC methods. Although the estimated dose was well below NRC requirements, the NRC will continue to evaluate the details of the licensee's dose assessment with respect to historical and future dose estimates during subsequent inspections.

.4 Evaluation of potential sources of underground leakage

a. Inspection Scope

The inspectors reviewed the analysis of groundwater monitoring wells installed onsite to determine the hydrogeology characteristics of the site. Based on these measurements, the inspectors evaluated the licensee's characterization of the groundwater contamination both onsite and offsite and the origin of that contamination. The inspectors verified that identified areas of underground contamination within the protected area of the facility near the turbine building were adequately incorporated into the licensee's fleet wide initiative to "evaluation of systems that handle radioactively contaminated water."

b. Findings

\_\_\_\_\_ No findings of significance were identified.

2PS3 Radiological Environmental Monitoring Program (REMP) And Radioactive Material Control Program

.1 Evaluation of preliminary results from routine environmental water sample locations

a. Inspection Scope

The inspectors reviewed the concentrations of liquid radioactive material that were measured in the environment from January 2005 through December 2005. The inspectors reviewed the results of the composite samples collected at the circulating water blowdown discharge point, just before the water enters the Kankakee River. Based on these measurements, the inspectors evaluated the results of the composite samples collected at the input to the Wilmington municipal water system, which collects

water from the Kankakee River downstream of the plant. The inspectors also reviewed the results of ground water samples near the Kankakee River and surface water samples collected from the Kankakee River downstream of the plant. The inspectors reviewed this data to ensure that any environmental impact from plant operations was adequately evaluated by the licensee as required by its Offsite Dose Calculation Manual and Technical Specifications.

b. Findings

\_\_\_\_\_ No findings of significance were identified.

**4. OTHER ACTIVITIES**

4OA3 Event Follow-Up (71153)

.1 Events that resulted in tritium contamination in unrestricted areas

a. Inspection Scope

The inspectors reviewed the licensee's historical records of circulating water blowdown line vacuum breaker leakage, including the licensee's root cause evaluation report and applicable condition reports. The inspectors also conducted staff interviews and physical walkdown of the facility. Based on that review, the inspectors developed a timeline of events (Appendix C) associated with the tritium contamination to fully understand the events and the licensee's response to those events.

b. Findings

Findings are documented in Section 2PS1.1.

.2 Radiological steam release from relief valve

a. Inspection Scope

The inspectors reviewed the licensee's initial radiological assessment and actions concerning a release of steam that was discharged from a failed relief valve in the feedwater system on April 6, 2006. The relief valve provides over pressure protection for the feedwater heater drain cooler and contains low levels of tritium. The inspectors evaluated the licensee's preliminary results of air and water samples taken in the immediate area of the release and the actions taken to mitigate the spread of potentially contaminated steam/water. In addition, the inspectors reviewed the licensee's preliminary radiological assessment for a group of workers who were in the area nearby the steam release. The inspectors assessed the licensee's actions to ensure that NRC requirements (e.g., 10 CFR 20, Technical Specifications, and licensee procedures) were adequately implemented.

b. Findings

On Thursday, April 6, 2006, a relief valve failed open on the shell side of the drain cooler in the feedwater system. The relief lifted at 1:25 p.m. (Central time), and the licensee was successful in isolating the drain cooler and the release at about 5:47 p.m. (Central time). Based on water usage from the condensate storage tank, the licensee estimated that about 114,000 gallons of steam/water was released from the Turbine Building through the relief valve.

A group of workers (approximately 10 persons) was working on the primary water storage tanks, which were in the vicinity of the steam release. The licensee discussed with the inspectors its evaluation of the potential exposure of the persons to the steam and its application of procedure RP-AA-220, Revision 03, "Bioassay Program." Since the airborne levels of tritium were less than the licensee's detection limits, the licensee's program and procedures did not require specific bioassay monitoring, which was consistent with the NRC requirements for monitoring contained in 10 CFR Part 20.

The licensee collected samples of condensed steam that accumulated as surface water on areas of the site. The licensee detected tritium at levels of about 41,000 to 46,000 pCi/l in samples near the release point. The licensee also obtained samples from a drainage ditch that was located near the licensee's property line and measured tritium levels of about 400 - 600 pCi/l. Immediately following the release, the licensee installed dams to prevent the contaminated water from migrating across the site boundary. The licensee also collected the surface water and was storing the water in temporary onsite tanks. The licensee indicated that it was planning to conduct additional soil and groundwater samples to ensure the full extent of the contamination was determined and to assess how potential offsite dose from the release and any previous steam releases from the secondary system which will be reviewed in future NRC inspections.

4OA5 Other Activities

.1 (Closed) Unresolved Item (URI) 05000456, 457/2005010-02: Tritium contamination from past vacuum breaker leaks on circulating water blowdown line

The inspectors reviewed the licensee's actions to determine whether the licensee had fully characterized the extent of the tritium contamination, whether the source of the contamination was properly identified, whether the licensee had correctly evaluated the integrity of the blowdown line, whether corrective actions were appropriately developed to prevent future releases from the blowdown line, and whether the licensee adequately evaluated potential mitigative actions for the tritium already released. The results of that review are described in Section 2PS1. The licensee's corrective actions and potential mitigative actions will be reviewed by NRC during future inspections. This URI is closed.

#### 4OA6 Meetings

##### .1 Exit Meeting

The inspectors presented the inspection results to Mr. K. Polson and other members of licensee management at the conclusion of the inspection on May 25, 2006. The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

## **SUPPLEMENTAL INFORMATION**

### **KEY POINTS OF CONTACT**

#### Licensee

K. Ainger, Regulatory Affairs  
R. Claes, Project Engineer  
J. Eggart, Chemistry  
J. Goesnell, Project Engineer  
A. Haeger, Tritium Team Manager  
P. Harvey, Hydrologist - Contractor  
J. Moser, Radiation Protection Manager  
J. Vano, System Engineer

### **ITEMS OPENED, CLOSED, AND DISCUSSED**

#### Opened

05000456, 457/2006008-01	AV	Failure to perform surveys to assure compliance with 10 CFR 20.1301, which limits radiation exposure to 0.1 rem. (Section 2PS1)
05000456, 457/2006008-02	AV	Failure to determine dose contributions with the methodology and parameters in the ODCM. (Section 2PS1)
05000456, 457/2006008-03	AV	Failure to establish an appropriate surveillance and monitoring program to evaluate the relationship between quantities of radioactive material released in effluents and resultant doses to individuals from principal pathways of exposure. (Section 2PS1)
05000456, 457/2006008-04	AV	Failure to keep records of spills or other unusual occurrences involving the spread of contamination in and around the facility for the 1996 or 1998 vacuum breaker leaks. (Section 2PS1)
05000456, 457/2006008-05	AV	Failure to identify the occurrence of unplanned release of radioactive liquid effluent that correspond to the vacuum breaker leaks to areas beyond the site boundary in the Annual Radiological Environmental Operating Report for 1996 or 1998. (Section 2PS1)

Closed

05000456, 457/2005010-02

URI Tritium contamination from past vacuum breaker  
leaks on circulating water blowdown line  
(Section 4OA5)

## LIST OF DOCUMENTS REVIEWED

The following is a list of licensee documents reviewed during the inspection, including documents prepared by others for the licensee. Inclusion on this list does not imply that NRC inspectors reviewed the documents in their entirety, but rather, that selected sections or portions of the documents were evaluated as part of the overall inspection effort. Inclusion of a document in this list does not imply NRC acceptance of the document, unless specifically stated in the inspection report.

### 2PS1 Radioactive Gaseous and Liquid Effluent Treatment and Monitoring Systems

Root Cause Evaluation (RCE), "Circ Water Blowdown Line Vacuum Breaker Failure Due to Low Stress, High Cycle Fatigue, Resulting in Flooding of Owner Controlled Property and Discharge Outside of NPDES Approved Path;" dated December 5, 2000

RCE "Inadequate Response to Unplanned Environmental Tritium Releases from Braidwood Station Due to Weak Managerial Oversight and the Lack of Integrated Procedural Guidance;" dated February 14, 2006

Tritium Investigation; dated March 2006

Braidwood Station Annual Radiological Environmental Operating Report, Docket Number STN 50-456 and STN 50-457; dated April 2, 1997

1998 Annual Radiological Environmental Operating Report; dated May 14, 1999

1999 Annual Radioactive Effluent Report; dated April 27, 2000

2000 Annual Radioactive Effluent Report; dated April 25, 2000

2001 Annual Radioactive Effluent Report; dated April 26, 2002

2002 Annual Radioactive Effluent Report; dated April 25, 2003

2003 Annual Radioactive Effluent Report; dated April 30, 2004 and June 23, 2004

2004 Annual Radioactive Effluent Report; dated April 27, 2005

File - 10 CFR 50.75(g) for Circulating Water Blowdown Leak of November 26, 2000, Books 1 and 2

Action Report (AR) No. 00328451; dated April 1, 2005

AR 00428868; dated November 30, 2005

Problem Identification Form (PIF) No. A1998-04324; dated December 04, 1998

PIF No. A2000-04281; dated November 6, 2000

TR-01-2006 DMA-TR-27; "Assessment of Offsite Doses from Inadvertent Releases of Water from the Blowdown Line at Braidwood Station;" dated March 28, 2006

2PS3 Radiological Environmental Monitoring Program (REMP) And Radioactive Material Control Program

MONTHLY CIRCULATING WATER BLOWDOWN FORM, BwCP 1003-5T1; Revision 6; January 2005 through December 2005

4OA3 Event Follow-Up

AR 00475790 25B Drain Cooler Shell Side Relief Valve Lifted (2DV021B)



## LIST OF ACRONYMS USED

AV	Apparent Violation
CFR	Code of Federal Regulations
CR	Condition Report
IMC	Inspection Manual Chapter
LLD	Lower Limit of Detection
ODCM	Offsite Dose Calculation Manual
pCi/L	picocuries per liter
REMP	Radiological Environmental Monitoring Program
SDP	Significance Determination Process
VB	Vacuum Breaker

Appendix A  
Tritium Sample Results

Braidwood Tritium Sample Results			NRC Split Sample Results		
Licensee <sup>4</sup> Sample Designation	Collection Date	pCi/L <sup>1</sup>	pCi/L <sup>1</sup>	NRC Sample ID	Ratio Licensee to NRC <sup>2</sup>
P-1	12-01-05	2484	2930	NRC-1-R3	0.848
P-4	12-01-05	33041	33630	NRC-2-R3	0.982
P-5	12-01-05	6621	6820	NRC-3-R3	0.971
P-6	12-01-05	450	190 <sup>3</sup>	NRC-4-R3	Statistically Insignificant
P-7	12-01-05	1210	1200	NRC-5-R3	1.008
P-8	12-01-05	2998	2720	NRC-6-R3	1.102
RW-1	12-01-05	2050	2650	NRC-7-R3	0.774
RW-2	12-01-05	33736	34760	NRC-8-R3	0.971
BL-17	12-01-05	25	240 <sup>3</sup>	NRC-9-R3	Statistically Insignificant
BL-18	12-01-05	108	150 <sup>3</sup>	NRC-10-R3	Statistically Insignificant
BL-19	12-01-05	37	300 <sup>3</sup>	NRC-11-R3	Statistically Insignificant
PW-9	12-05-05	142	-340 <sup>3</sup>	NRC-12-R3	Statistically Insignificant
PW-11	12-05-05	99	100 <sup>3</sup>	NRC-13-R3	Statistically Insignificant
PW-4	12-02-05	43	200 <sup>3</sup>	NRC-14-R3	Statistically Insignificant
SW-4	12-02-05	83	210 <sup>3</sup>	NRC-15-R3	Statistically Insignificant
PW-8	12-03-05	1151	1490	NRC-16-R3	0.772
D-3	12-02-05	137	-60 <sup>3</sup>	NRC-17-R3	Statistically Insignificant
RW-3	12-02-05	197	140 <sup>3</sup>	NRC-18-R3	Statistically Insignificant
RW-4	12-02-05	380	420 <sup>3</sup>	NRC-19-R3	0.905

Appendix A  
Tritium Sample Results

Braidwood Tritium Sample Results			NRC Split Sample Results		
P-2	12-02-05	4344	2750	NRC-20-R3	1.580
P-3	12-02-05	3258	2470	NRC-21-R3	1.319
VB3-7	12-02-05	169	-90 <sup>3</sup>	NRC-22-R3	Statistically Insignificant
VB3-8	12-02-05	171	110 <sup>3</sup>	NRC-23-R3	Statistically Insignificant
PW-1	11-30-05	-26	200 <sup>3</sup>	NRC-24-R3	Statistically Insignificant
PW-2	11-30-05	48	180 <sup>3</sup>	NRC-25-R3	Statistically Insignificant
PW-3	11-30-05	25	-250 <sup>3</sup>	NRC-26-R3	Statistically Insignificant
PW-8	12-06-05	1524	1020	NRC-27-R3	1.494
SW-1	11-30-05	2464	2480	NRC-28-R3	0.994
SW-2	11-30-05	2347	2490	NRC-29-R3	0.943
G-1	12-06-05	133	290 <sup>3</sup>	NRC-30-R3	Statistically Insignificant
G-2	12-06-05	87	230 <sup>3</sup>	NRC-31-R3	Statistically Insignificant
G-3	12-06-05	81	140 <sup>3</sup>	NRC-32-R3	Statistically Insignificant
P-9	12-05-05	1346	-40 <sup>3</sup>	NRC-33-R3	Statistically Insignificant
P-10	12-05-05	1934	2120	NRC-34-R3	0.912
P-11	12-05-05	1681	1770	NRC-35-R3	0.950
P-12	12-05-05	1535	1400	NRC-36-R3	1.096
S-1	12-05-05	-21	-70 <sup>3</sup>	NRC-37-R3	Statistically Insignificant
S-2	12-05-05	95	110 <sup>3</sup>	NRC-38-R3	Statistically Insignificant
S-3	12-05-05	145	140 <sup>3</sup>	NRC-39-R3	Statistically Insignificant
S-4	12-05-05	1280	1230	NRC-40-R3	1.041

Appendix A  
Tritium Sample Results

Braidwood Tritium Sample Results			NRC Split Sample Results		
S-5	12-05-05	2023	2190	NRC-41-R3	0.924
S-6	12-05-05	679	490 <sup>3</sup>	NRC-42-R3	1.386
D-4	12-06-05	91	-30 <sup>3</sup>	NRC-43-R3	Statistically Insignificant
D-2	12-05-05	125	-40 <sup>3</sup>	NRC-44-R3	Statistically Insignificant
P-4	12-06-05	25311	30020	NRC-45-R3	0.843
P-8	12-06-05	2212	2500	NRC-46-R3	0.885
VB2-6	12-05-05	2348	1640	NRC-47-R3	1.432
VB3-4	12-05-05	43708	42580	NRC-48-R3	1.026
MW-113	12-05-05	3598	3840	NRC-49-R3	0.937
NRC Sample (VB 3-4)	11-30-05		39400	NRC-50-R3	
D-5	12-02-05	73	280 <sup>3</sup>	NRC-51-R3	Statistically Insignificant
NRC Sample (PW-3)	12-07-05		280 <sup>3</sup>	NRC-52-R3	
NRC Sample (PW-2)	12-08-05		210 <sup>3</sup>	NRC-53-R3	
NRC Sample (PW-1)	12-08-05		150 <sup>3</sup>	NRC-54-R3	
PW-5	12-07-05	9	310 <sup>3</sup>	NRC-55-R3	Statistically Insignificant
PW-10	12-07-05	72	210 <sup>3</sup>	NRC-56-R3	Statistically Insignificant
PW-12	12-07-05	44	190 <sup>3</sup>	NRC-57-R3	Statistically Insignificant
PW-7	12-07-05	-58	170 <sup>3</sup>	NRC-58-R3	Statistically Insignificant
PW-13	12-07-05	-62	100 <sup>3</sup>	NRC-59-R3	Statistically Insignificant
VB3-4D	12-14-05	747	910	NRC-60-R3	0.821
VB3-9D	12-13-05	21715	21720	NRC-61-R3	1.000

Appendix A  
Tritium Sample Results

Braidwood Tritium Sample Results			NRC Split Sample Results		
MW-113D	12-14-05	4835	4810	NRC-62-R3	1.005
P-2D	12-12-05	2599	2480	NRC-63-R3	1.048
RW-2@10'	12-13-05	54111	55920	NRC-64-R3	0.968
RW-2@20'	12-13-05	171166	160400	NRC-65-R3	1.067
RW-2@25'	12-13-05	246442	281800	NRC-66-R3	0.875
NRC Sample (PW-8)	12-27-05		1310	NRC-67-R3	
NRC Sample (SW)	12-08-05		-30 <sup>3</sup>	NRC-68-R3	
NRC Sample (PW-8)	12-08-05		1360	NRC-69-R3	

<sup>1</sup>The negative numbers indicated radioactivity statistically indistinguishable from background radiation or from the laboratory's Lower Limit of Detection (LLD).

<sup>2</sup>The term Statistically Insignificant applied when sample results are near the LLD.

<sup>3</sup>The NRC's contract laboratory's LLDs:

- S drinking water wells 200 picocuries per liter
- S non-drinking water wells 500 picocuries per liter

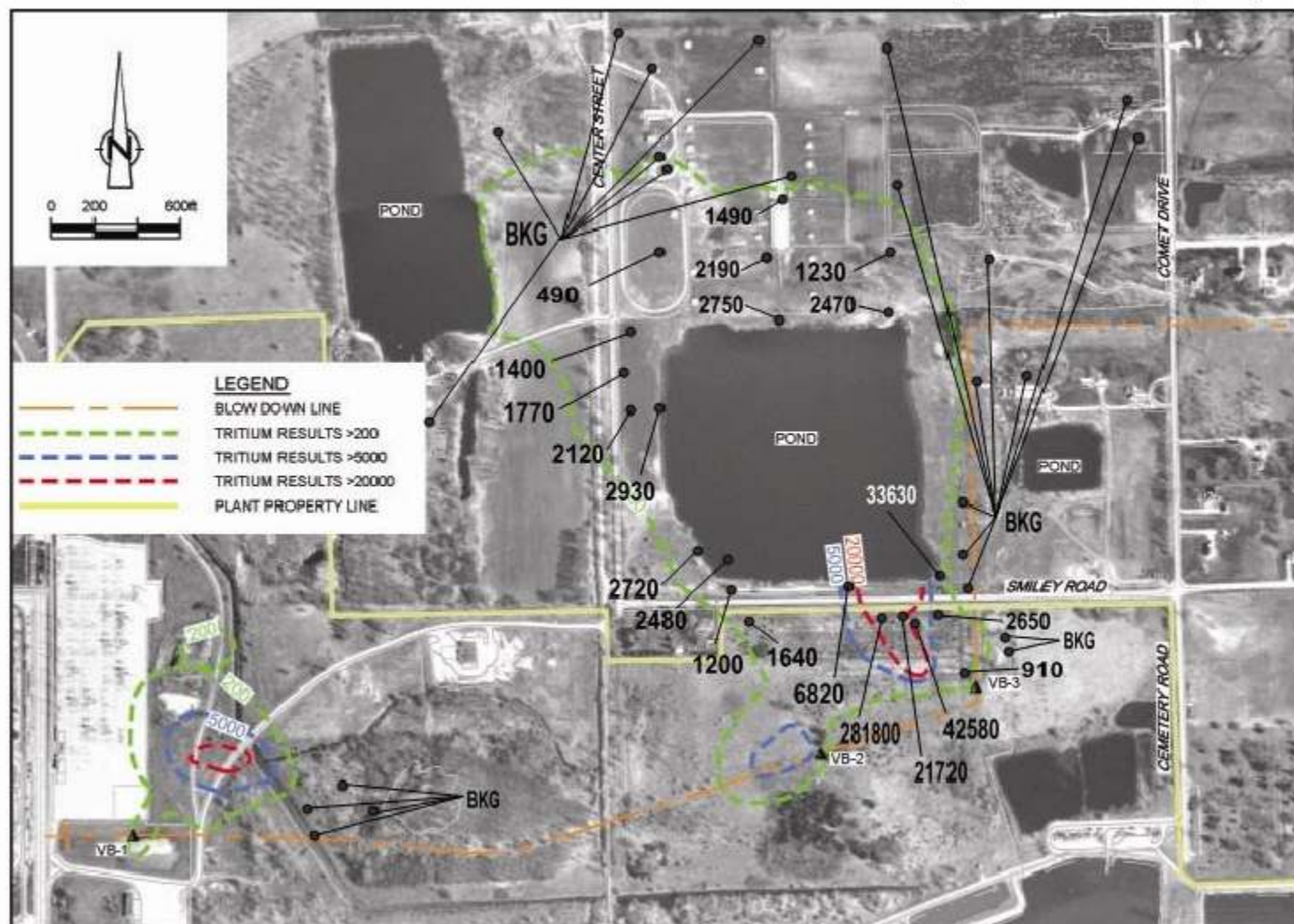
<sup>4</sup>The Licensee Sample Designation code provides some indication of the location:

- |    |                        |    |                  |
|----|------------------------|----|------------------|
| BL | Blowdown Line          | PW | Private Well     |
| D  | near the on-site Ditch | RW | Remediation Well |
| G  | Private Well           | S  | Private Well     |
| MW | Monitoring Well        | SW | Surface Water    |
| P  | Pond                   | VB | Vacuum Breaker   |

## Appendix B

### NRC Groundwater Measurement Results

(December 2005 - February 2006)



BKG = Concentrations at or below normal environmental background levels  
Numerical results in picocuries per liter

## Appendix C Sequence of Events

Date	Description of Events
11/1996 - 07/1997	Based on a Braidwood work order (WO), the licensee repaired a 1-inch pipe break associated with Vacuum Breaker No. 1 (VB-1) along the circulating water blowdown line. The pipe break resulted in an onsite release of an estimated 250,000 gallons of water containing radioactive effluent from the blowdown line. Since the Licensee did not recognize the radioactive component of the leakage, the Braidwood staff did not sample the leakage for radioactive material.
01/1998	Braidwood WO indicated that the licensee repaired a small leak on VB-2, which is located onsite. No documentation could be found concerning the size of the leak or if the leak was sampled for radioactive material.
12/1998	Braidwood WO indicated that the licensee repaired a significant leak on VB-3, which resulted in an estimated release of 3,000,000 gallons of water to areas onsite and into a drainage ditch along Smiley Road. The licensee also documented the incident in a corrective action document, but that document did not indicate that radioactive material was involved. Since the Licensee did not recognize the radioactive component of the leakage, the Braidwood staff did not sample the leakage for radioactive material; however, onsite soil contamination was detected in April of 2001.
11/2000	<p>The Illinois Environmental Protection Agency received a call from a local resident concerning water that was pooling on Braidwood property and in a ditch along the south side of Smiley Road, which borders the site. The Illinois Environmental Protection Agency notified the Braidwood facility of the report.</p> <p>Braidwood staff identified that the float in valve VB-2 had been damaged, resulting in an 8-inch opening in the valve. The Braidwood staff estimated that the opening in the valve resulted in a release of approximately 3,000,000 gallons of water containing radioactive liquid effluent from the blowdown line onto the ground. The Braidwood staff and the Illinois Department of Nuclear Safety measured tritium at levels of approximately 20,000 - 35,000 picocuries per liter in the drainage ditch on the south side of Smiley Road. The Braidwood staff also identified radioactively contaminated soil onsite.</p> <p>On November 9, 2000, the Braidwood staff notified the NRC Region III Office and Illinois Department of Nuclear Safety of the contamination found in the Smiley Road ditch.</p> <p>On November 10, 2000, the Braidwood staff began pumping the standing water back to the blowdown line to the Kankakee River.</p>
11/2000	Braidwood WO indicated that a small leak was repaired on the valve seat of VB-6. No documentation could be found concerning the size of the leak or if the leak was sampled for radioactive material.

Appendix C  
Sequence of Events

11/2000	Braidwood WO indicated that a leak was repaired on VB-1. No documentation could be found concerning the size of the leak or if the leak was sampled for radioactive material.
04/2001	The Braidwood staff issued the 2000 Radioactive Effluent Release Report that documented the November leakage from VB-2 as an abnormal release.
06/2001	Braidwood WO indicated that the licensee repaired a leak on VB-3, which was located onsite. No documentation could be found concerning the size of the leak or if the leak was sampled for radioactive material.
06/2001	Braidwood corrective action document indicated that non-contaminated water was found in the valve vault for VB-9. No documentation could be found concerning the size of the leak.
06/2001	Braidwood corrective action document indicated that non-contaminated water was found in the valve vault for VB-10. No documentation could be found concerning the size of the leak.
06/2001	Braidwood corrective action document indicated that water was found in the valve vault for VB-11. No documentation could be found concerning the size of the leak or if the leak was sampled for radioactive material.
05/2002	Braidwood WO indicated that a leaking air release valve was replaced on VB-3. No documentation could be found concerning the size of the leak or if the leak was sampled for radioactive material.
08/2003	Braidwood corrective action document and/or WO indicated that leakage was identified on VB-4 during modification testing. No particulate radioactivity was detected. No documentation could be found concerning the size of the leak. Braidwood staff notified the NRC resident inspector of the leakage and that no radioactive material was detected.
09/2003	Braidwood WO indicated that small leak was identified on VB-4 at low system operating flow. No documentation could be found concerning the size of the leak or if the leak was sampled for radioactive material.
11/2004	Braidwood WO indicated that a leak was identified on VB-8 (within the valve vault). The valve was subsequently replaced. No documentation could be found concerning the size of the leak or if the leak was sampled for radioactive material.
03/2005	The Illinois Environmental Protection Agency notified the Braidwood site of an investigation into potential tritium contamination in wells near the Braidwood site.



Appendix C  
Sequence of Events

03/2005 - 11/2005	Beginning in March 2005, the Braidwood staff expanded the onsite groundwater monitoring program. During that expansion, the Braidwood site identified elevated levels in tritium in onsite groundwater monitoring wells.
05/2005	Braidwood WO indicated that a leak was identified on VB-1, which was repaired. Licensee documentation indicated that the leak rate was approximately 20 drops per minute. The licensee's limited survey documentation indicated that approximately 50,000 picocuries per liter of tritium was measured in water from the valve vault. However, no additional survey documentation could be located.
05/2005	Braidwood WO indicated that a leak was identified on VB-6 that resulted in about 1-foot of water in the valve vault. The valve was subsequently rebuilt by the Braidwood staff.
11/2005	On November 23, 2005, the Braidwood staff stopped all radioactive releases through the circulating water blowdown line based on the results of onsite monitoring efforts. On November 30, 2005, the NRC Region III office was notified by the Braidwood staff of an elevated tritium measurements in a Braidwood onsite groundwater well.
01/2006	Braidwood identified a leak on VB-7, which resulted in non-radioactive release of water to the environment.